# CHAPTER 4. EXISTING CONDITIONS

This chapter provides an overview of current conditions in the study area, particularly in the problem identification area. During Phase II of the Comprehensive Study, the information in this section will be expanded to address other parts of the study area. A description of existing conditions becomes the baseline from which future without-action and future with-action conditions are forecasted, and against which these potential future conditions are measured. A clear description of existing conditions also helps to identify problems and opportunities in the study area.

This chapter is organized into three sections. The first section provides a system-wide perspective on existing conditions; the next sections cover the Sacramento River basin and the San Joaquin River basin.

## SYSTEM-WIDE CONTEXT AND CONDITIONS

### ECOSYSTEM STRUCTURE AND PROCESSES

Ecosystems are dynamic and involve interrelationships between physical structures and biological functions which form diverse environmental features as a consequence of these relationships. Humans are an integral element of all ecosystems. People are affected by ecosystem interrelationships and humans activities, in turn, often significantly modify ecosystem structure and function.

Rivers provide many ecosystem values. They function as habitat for myriad aquatic and terrestrial plants and animals. Rivers also function to pass flood flows, convey water for urban and agricultural areas, transport urban and agricultural waste water, and provide transportation corridors for commercial and recreational vessels. Important physical functions include erosion, sediment transport, and sediment deposition. These processes create a dynamic system in which sediment deposition provides opportunities for plant establishment in one location, while erosion operations to eliminate mature plant communities in other locations. The river meandering process leads to successional changes and these changes create a dynamic balance of successional communities within the ecosystem. The resultant community mosaic optimizes biological diversity in the system.

There are numerous ecological interactions between the river channel and the floodplain. For example, floodplain vegetation provides shading, contributes materials and nutrients which serve as food for aquatic organisms, and adds large woody debris. During prolonged inundation, salmon and other fish feed within the inundated floodplain. Before 1850, the connections between rivers and floodplains in the Central Valley were more integrated and extensive than they are in most places today. These connections provided important pathways for the exchange of energy and materials. Even along rivers where floodplain inundation was typically brief, interactions were nonetheless essential in recharging the alluvial water table, dispersing the seeds of riparian plants, and increasing soil moisture on surfaces elevated above water tables. These factors contributed to maintenance of floodplain aquatic habitats, such as side channels, ox bow lakes, and phreatic channels.

Floodplain soils and vegetation can improve water quality in rivers by filtering sediments from runoff. In addition, chemical reactions in the floodplain alluvium can remove nitrogen (and other constituents) from agricultural or urban runoff. These same areas also provide habitat for water birds, resident, and migratory species.

Ecosystem dynamics are far more complex than physical and ecological processes indicate. Factors affecting habitat area, temporal and spacial variability, and continuity should also be considered integral parts of the living system. Human actions have modified and restricted ecological processes to the extent that only limited ecological functions occur. Total ecological function cannot be regained, but a simulation of the processes can be integrated into flood management. For example, seasonally inundated floodplains may provide significant benefits to native fish which require a shallow flooded habitat for part of their life cycle. These species may gain additional benefits because many native fish are better adapted to floodplain environments than are most non-native species.

## FISH AND AQUATIC ECOSYSTEMS

The Sacramento and San Joaquin Rivers and their associated tributaries once supported large runs of chinook salmon. These salmon in turn sustained robust commercial and recreational fisheries. However, since the gold rush in 1949, chinook salmon populations have declined significantly. Prior to the gold rush, the chinook salmon population in the Valley was estimated to be 800,000 to 1.5 million (Yoshiyama et. al., 1996). Between 1967 and 1991, an average of 250,000 fish returned annually to the rivers to spawn (USFWS 1998).

In recent years, low population levels of chinook salmon and steelhead trout have warranted their listing or proposed listing under State and Federal Endangered Species Acts. Winter-run chinook are listed as endangered under the Federal ESA; they are listed as threatened under the State ESA. Spring-run chinook salmon are proposed as endangered on the Federal ESA list; and as threatened by the State ESA. The fall/late fall-run is proposed as threatened under the Federal ESA; California has not proposed the fall/late fall-run for listing. Central Valley steelhead are listed as threatened under the Federal ESA. The State ESA has not listed or proposed steelhead for protection.

Beginning in 1949, dredging and hydraulic mining produced large quantities of sediments that were deposited downstream, altering fish habitats in the streams and rivers. During the late 1800s and early 1900s, agricultural development and levee construction for flood management, eliminated much of the original marshland and riparian habitat supporting the aquatic ecosystem. Debris control, flood control, and water supply projects developed by Federal, State, local, and private entities included dams that blocked fish access to the upper portions of most major rivers in the Central Valley. Water storage and diversions altered natural river flow patterns, while fish entrainment at water diversions affected juvenile fish.

Large-scale hatchery production of chinook salmon and steelhead has not adequately mitigated for the effects of dams in the Sacramento and San Joaquin River basins. In addition, many biologists believe hatcheries adversely affect the remaining wild stocks because hatchery raised fish interbreed with wild fish and because hatchery production facilitates high harvest rates of wild fish. Hatchery fish released at remote sites are not imprinted to specific areas; and tend to have higher straying rates than wild fish. These sites allow spawning of hatchery-produced fish in non-natal rivers (CVPIA 1997).

Agriculture, grazing, mining, logging, navigation, and urban development activities contributed to a decline in water quality in most fish habitats. Agricultural drainage increased salinity and concentrations of pesticides and other toxic substances in the rivers. Early cities, towns, and homesteads discharged untreated sewage into rivers causing eutrophication and oxygen depletion. Industries discharged toxic substances into the rivers. Removal of riparian vegetation increased sedimentation and water temperature in small streams used by chinook salmon and trout for spawning and rearing.

Today, unscreened water diversions continue to remove fish, invertebrates, and nutrients from the system. Migrating adults and juveniles are affected by stream flow, temperature, barriers, and other factors. In addition, modified flows in Delta channels caused by pumping operations may have adverse effects on migrating adults and juveniles by confusing migrants and delaying migration and/or lengthening migration routes. The Central Valley retains only five percent of its former spawning habitat for anadromous fish species (California Rivers 1993).

Many non-native aquatic species have been introduced into the Central Valley and its tributaries since the mid 1800's. The introduction of exotic species has often been seen as a way to improve commercial and sport fisheries. Most recent introductions to the Central Valley river systems have been accidental and linked to ballast water discharges from ocean-going vessels from foreign ports. In much of the river system, exotic species are so numerous that the compete with native species for resources and habitat.

The distribution and abundance of fish throughout the Central Valley and its watershed are affected by water temperature, instream flows, barriers to migration, access to historical spawning areas, entrainment in diversions, fishing, and available habitat quantity and quality. Federal, State, local, and private entities are acting to improve conditions for anadromous fish species in the Central Valley through programs such as CALFED and CVPIA. These programs have outlined steps to recover anadromous fish populations and are in the process of implementing recovery measures. Many of the measures proposed in these programs entail modification of the physical and or operational aspects of the flood management systems.

## PLANT COMMUNITIES, WILDLIFE, AND TERRESTRIAL ECOSYSTEMS

Terrestrial ecosystems in the Central Valley are comprised of a number of broad habitat types which support a wide diversity of plants and animals. Habitat types include open water, wetlands, vernal pools, riparian areas, uplands, and agricultural lands. The Central Valley is the most vital waterfowl wintering area on the Pacific Flyway, and supports approximately 60 percent of the flyway populations. Waterfowl and shorebirds forage primarily in natural and artificial wetlands, and in agricultural lands within the basin.

California is home to more special-status species than any other state in the nation except Hawaii. Special-status species are plants and animals that are recognized as rare by State and Federal agencies and conservation groups. They include Federally-listed and State-listed threatened or endangered species, as well as species of concern. Many of these rare species occur in the Sacramento and San Joaquin River basins, and include terrestrial and aquatic plants and animals. Species distribution and abundance are affected by a number of factors but biologists generally agree that habitat modification and habitat loss have significantly contributed to the decline of many species. In the Central Valley, some species have completely disappeared from the region. Others, have nearly disappeared.

## SOCIOECONOMICS

### Demographics

In 1990, the population of California was an estimated 29,760,000. The rapidly growing cities of the Central Valley have increased the population of the Sacramento River, San Joaquin River, and Tulare Lake basins to approximately 5,420,000 people. The majority of the population in these regions is concentrated in relatively small parts which include the greater metropolitan areas of Redding, Marysville/Yuba City, Sacramento, Stockton, Modesto, Fresno, and Bakersfield.

The state population is presently about 20 times greater than it was in 1900, when it was estimated at 1.5 million. This population increase has profoundly increased the use of land and water in the Central Valley for water supply, recreation, and agricultural and urban development.

### Economics

The Central Valley is the major agricultural region for California and a significant region in the United States. This valley possesses nearly 80 percent of the irrigated land in California. In 1993, the 19 Central Valley counties contributed more than 60 percent, by value, of state agricultural production, and included six of the top ten agricultural counties in California.

Agriculture is a primary employer in the Central Valley, influencing the regional economy through farm expenditures, as well as production of many crops that require processing or transportation after harvest.

This productive region accounts for almost 10 percent of the total national market value of agricultural crops sold. More than half of this value comes from fruits and nuts. The Central Valley accounts for almost 40 percent of national production of fruits and nuts. The valley also produces 15 percent of the nation’s vegetables and 20 percent of the nation’s cotton. The Central Valley is a major player in international markets. California produces about 10 percent of the total national agricultural exports. The Valley grows virtulaly all of the state’s cotton and almonds, and nearly three-fourths of its grapes and oranges. These exports represent about 25 percent of the State’s gross farm income.

## LAND USE

### Urban Lands

The first municipal and industrial land use in California was concentrated in or near the coastal areas. During the last twenty years, this trend has shifted. The rate of new development in coastal areas has declined as the availability of developable land has decreased and the prices of remaining available land have risen. This trend is evident in the relationship between the San Francisco Bay region and the areas of Sacramento and San Joaquin counties. During the 1980's, communities in the Sacramento, Tracy, and Stockton areas have grown partially with residents who commute to Livermore, Walnut Creek, and other areas of the San Francisco Bay region. In 1990, municipal and industrial lands comprised 450,000 acres in the Sacramento River basin and over 100,000 acres in the San Joaquin River basin.

### Agricultural Land Use

Agriculture in California has progressed through several distinct phases, and some of the earliest influences are still present today (Branch and Poremba, 1990 and the U.S. Bureau of Reclamation [Reclamation], 1949). The most recent phase included the development of the Central Valley Project (CVP) and the State Water Project (SWP), and increased use of groundwater for irrigation due to advances in pump design and capacity.

Irrigated cropland increased in the 1960's and 1970's because of further water development, although the number of farms and farm population decreased. Agriculture was also adversely affected during the 1970's by commodity shortages, high energy prices, high interest rates, changes in Federal government farm programs, and drought. During the 1980's and early 1990's, taxes were lowered, interest rates fell, immigration was reformed, and farm legislation underwent changes.

California agriculture suffered through an extended drought from 1987 to 1992. Many thousands of acres of farmland were idled (Northwest Economic Associates, 1993). Water deliveries were curtailed from both the CVP and SWP, and those farmers able to do so pumped additional groundwater. Other farmers utilized the State Water Bank and other water transfers.

The 1992 U.S. Census reported slightly more than 41,000 farms in the Central Valley, a little more than half of the total farms in California. Between 1987 and 1992, there were no significant changes in number of farms, farm sizes, or general farmland use between 1987 and 1992. The number of farms, and land in farms, decreased slightly between 1987 and 1992; average farm size remained fairly constant at a little more than 350 acres per farm. About 90 percent of the farms contained less than 500 acres; 5 percent covered between 500 and 999 acres; and 5 percent covered 1,000 acres or more in either census year of 1987 and 1992. In 1992, about half of the land in farms in the Valley was dedicated to cropland, 80 percent to harvested crops, and 20 percent to pasture and grazing. In 1987, these figures were 75 percent and 25 percent, respectively, to cropland, and pasture and grazing. The proportion of irrigated cropland rose slightly from 76 percent in 1987 to 78 percent in 1992.

***Prime and Unique Farmlands.*** Specifically designated farmlands are of concern to the Comprehensive Study. This is why one of the GIS layers obtained for the Comprehensive Study delineates prime and unique farmlands by county. This information shows that within the Sacramento Basin and in the area of possible economic impact, there are 419,000 acres of prime farmland and 16,000 acres of unique farmland. In the San Joaquin Basin, within the areas of possible economic impact, the number is 224,200 acres of prime farmland and 86,100 acres of unique farmland.

***Agricultural Economics.*** Estimates of agricultural costs, revenues, and net returns vary substantially among sources. These variations result primarily from differences in survey sample, timing of surveys, and assumptions regarding cost calculations. Data described here are from the Census of Agriculture in 1989 and 1994. They are presented to provide a consistent comparison of Central Valley conditions similar to conditions in California and in the nation.

Hired and contract labor was the largest expense reported, accounting for one-fourth of total expenses. Other large categories (other than livestock-related expenses) were fertilizers and chemicals, petroleum products and electricity, and interest paid.

Values of crop production per acre can range from $200 to $15,000 or more. In comparison to the nation as a whole, a large share of Central Valley irrigated lands is used to produce “high-value crops.” High-value crops tend to be used for direct human consumption. They generate more revenue per acre, but they also require more labor and other inputs.

Central Valley farms accounted for more than $8.5 billion in agricultural sales in 1987 and $10 billion in 1992. About two-thirds of these sales were receipts for crops. The remainder of the sales were mostly livestock products. Farmers received an additional $329 million in Federal government payments, and $171 million from direct sales, custom work, and other farm services for a total income of $10.5 billion in 1992. Production expenses were about $8.2 billion, leaving a net cash return of $2.4 billion.

About 56 percent of Central Valley farms are operated by persons who claim farming as their principal occupation; 70 percent are operated by full owners, 17 percent by part owners, and 13 percent by tenants. These figures suggest that most farmers and land owners in the Central Valley live in the region. (Reclamation, 1995).

### Wildlands and Conservation Lands

Lands have been identified for conservation purposes throughout the Sacramento and San Joaquin River basins. Some of these lands protect scarce habitats or rare plants and animals. Other lands are designed to restore habitat, such as wetlands for waterfowl. Conservation lands are owned and managed by Federal, State, and local governments, and by private organizations and individuals. Over the past five years, California has restored and/or enhanced more than165,000 acres of wetlands while protecting an additional 62,000 acres through acquisition. There are 360,780 acres of existing protected wetlands habitats in the State.

In California, the Federal government manages about 427,000 acres through its system of National Wildlife Refuges. Many of these refuges are located in the Central Valley. Federal conservation easements influence management of additional lands for the benefit of plants and wildlife. The State of California operates about 76 Wildlife Management Areas, Ecological Reserves, and other public lands. Descriptions of the Federal and State refuges are provided in Appendix J.

Private organizations and individuals protect and manage wetland, upland, and other habitats. For example, The Nature Conservancy focuses on securing, protecting and restoring lands that support unique or representative assemblages of plants and animals. Private duck clubs own most wetlands in the Central Valley and manage these areas for waterfowl. Many duck clubs manage wetlands for waterfowl as part of a partnership with the Federal government through conservation easements. The California Waterfowl Association, The Nature Conservancy, Trust for Public Land, and the Audubon Society have acquired sensitive lands for preservation and restoration.

Agencies are developing partnerships and market-based approaches to encourage conservation at local and regional levels. Within the Wildlife Conservation Board, the Riparian Habitat Conservancy provides an example of these new initiatives. The Conservancy develops partnerships between government agencies and private organizations to conserve valuable riparian habitat. Since its inception, the program has acquired and improved more than 12,000 acres of riparian habitat throughout the State.

Conservation banks protect additional lands. These "banks" are wildlife habitat areas that are restored and permanently protected by selling credits to offset development impacts elsewhere. There are now more than 40 conservation banks throughout the state. These banks provide thousands of acres of wildlife habitat and protect land valued at more than $50 million.

## WATER SUPPLY

Water use in California is influenced by changes in population patterns and geographic location, and by drought. Between 1988 and 1990, the number of active service connections decreased in Los Angeles and increased in Fresno, reflecting short-run economic conditions in these two cities. Water use per connection decreased with the drought of 1987-1992, especially in Santa Barbara, which was under strict mandatory conservation. Annual use and average water bills vary greatly among providers. Summer and winter residential water use are nearly identical in the northern coastal cities, reflecting climate and landscaping practices. In the Central Valley, summer use per unit time is typically double the winter residential use. Average annual use per residential unit is about 0.72 acre-foot in Sacramento. Demand during dry periods is greater than average because there is less recharge of urban landscape soil moisture.

To provide water supply for the Central Valley, California has developed an extensive water supply system, the largest system in the United States. State surface water supplies are derived from an average annual statewide precipitation of about 23 inches, corresponding to a volume of nearly 200 million-acre-feet (maf). About 65 percent of this precipitation is consumed through evaporation and transpiration by trees and other plants. The remaining 35 percent comprises the State's average annual intrastate runoff of about 71 maf. Less than half of this runoff is depleted by urban or agricultural use. Most of it maintains ecosystems in the State's rivers, estuaries, and wetlands. Available surface water supply totals 78 maf when out-of-state supplies from the Colorado and Klamath Rivers are added.

Distribution of the State's water supplies varies geographically and seasonally. Water supplies also vary climatically through cycles of drought and flood. More than 70 percent of California's 71 maf average annual runoff occurs in the northern part of the State; the North Coast Region accounts for 40 percent and the Sacramento River Region accounts for 32 percent. About 75 percent of the State's urban and agricultural demands for water are south of Sacramento. The largest urban water use is in the South Coast Region where roughly half of the State's population resides. The largest agricultural water use is in the San Joaquin Valley. Wild and scenic river flows in the North Coast provide the largest environmental water use. To deal with the disparate geographical distribution of California's water resources, facilities were constructed to convey water from one watershed to another. The largest projects in the State are the Federal Central Valley Project (CVP) and the State Water Project (SWP). These projects are described in Chapter 2. Major features of both projects are situated in the Sacramento and San Joaquin River basins.

The keystone of the CVP is Lake Shasta, the largest reservoir in California, with a capacity of 4.55 maf. Other major project reservoirs include Folsom Lake on the American River, and Millerton Lake on the San Joaquin River. The CVP delivers about 7 maf annually for agricultural (6.2 maf), urban (0.5 maf), and wildlife refuge (0.3 maf) use. The majority of CVP water goes to agricultural water users in the Central Valley. Large urban centers receiving CVP water include Redding, Sacramento, Folsom, Tracy, most of Santa Clara County, northeastern Contra Costa County, and Fresno.

The major reservoir of the SWP is Lake Oroville, the second largest reservoir in California. The SWP contracts with 29 long-term water contractors to ultimately deliver 4.2 maf of water per year. Of this amount, about 2.5 maf is dedicated per year to serve Southern California and about 1.3 maf serves the San Joaquin Valley. The remaining 0.4 maf annual entitlement serves the Feather River, San Francisco Bay, and Central Coast areas.

Other major surface water development projects in the Sacramento and San Joaquin River basins are located on the Merced, Tuolumne, Calaveras, Mokelumne, and the Yuba-Bear Rivers. New Exchequer Dam impounds Merced Irrigation District's Lake McClure. This lake is the only large water supply reservoir in the Merced River basin and it has a capacity of 1 maf. New Hogan Reservoir is the only large reservoir on the Calaveras River, and it provides flood protection and water supply for the Stockton area. The Hetch Hetchy reservoir system on the Tuolumne River provides water to the San Francisco Bay area. Modesto and Turlock Irrigation Districts jointly divert about 1 maf/yr of Tuolumne River water for agricultural use. East Bay Municipal Utility District receives water from Camanche and Pardee Reservoirs on the Mokelumne River and conveys it to serve the East Bay. Surface water development on the Yuba and Bear Rivers provides supply to more than one dozen water purveyors serving the Cities of Marysville, Grass Valley, Nevada City, and many smaller communities.

Of the State's 43 maf of surface reservoir storage, over 65 percent resides in the Sacramento and San Joaquin River basins. Most large reservoirs are multipurpose impoundments designed to provide water supply storage, electric power, flood management, recreation, water quality, and downstream fishery needs. Often times, large reservoirs would not be economically feasible as single-purpose projects. Multipurpose designs optimize the beneficial uses of large reservoir sites and provide regional water supply benefits.

Groundwater supplies about 30 percent of California's urban and agricultural applied water use in an average water year. In drought years when surface water supplies are reduced, groundwater supports an even greater percentage of use, resulting in declining groundwater levels in many areas. The amount of water stored in California's aquifers is far greater than that stored in the State's surface water reservoirs, although only a portion of California's groundwater resources can be economically and practically extracted for use.

The Sacramento Valley is a major groundwater basin, with an estimated 114 maf of water in storage at depths of up to 600 feet. Well yields in alluvial areas vary significantly depending on location; pumping rates typically range from 100 to 4,000 gallons per minute (gpm). Foothill communities using groundwater generally rely on fractured rock sources having yields lower than those found in valley floor alluvium. Groundwater overdraft in the Sacramento River basin is about 33 thousand acre-feet (taf) under a 1995 level of development. Some increases in groundwater overdraft are expected in Sacramento, Placer, and El Dorado Counties, due to increased population demand.

Many urban areas in the San Joaquin River basin rely solely on groundwater for their supply. Groundwater overdraft occurs in much of the valley floor and is about 239 taf under the 1995 level of development.

Managed wetlands are owned and operated as State and Federal wildlife areas. Private wetland preserves are owned by non-profit organizations, or private duck clubs. Agricultural lands flooded to create waterfowl habitat are primarily rice fields in the Sacramento Valley and corn or other small grain crops in the Delta. Managed wetlands receive water from several sources, including groundwater, local surface water, imported surface water from the CVP, the SWP, and local projects, as well as agricultural return flows.

## CULTURAL RESOURCES AND INDIAN TRUST LANDS

### Cultural Resources

Cultural resources consist of prehistoric and historic resources, and traditional cultural properties. Prehistoric resources are the material remains of human activities that predate contact with non-Native Americans. Such resources include village sites, temporary campsites, lithic scatters, roasting pits/hearths, bedrock milling features, petroglyphs, pictographs, rock features such as hunting blinds and burials.

Historic resources are physical properties, structures, or built items that post-date written records. These resources entail both archaeological sites and architectural structures. Historic archaeological site types include townsites, homesteads, agricultural or ranching features, mining related features, and refuse concentrations. Historic architectural resources include houses, barns, and community structures such as churches, schools, stores, post offices and meeting halls.

Traditional cultural properties are sites, locations, or features that are associated with cultural practices or beliefs of a living community that are rooted in that community's history, and are essential in maintaining the continuing cultural identity of the community. Traditional cultural properties are most often associated with Native American practices and beliefs. However, other communities or cultural groups may acknowledge similar properties, such as sites that are an integral aspect of religious practices or beliefs, or areas where natural supplies are gathered to enhance the continuity of cultural traditions.

The lead agency evaluates all cultural resources using regulations set forth by the Secretary of the Interior, and technical guidelines issued by the National Park Service (NPS). The agency determines if a cultural resource retains the necessary attributes or significance for listing on the National Register of Historic Places(NRHP). If determined eligible for the NRHP, a resource will also be eligible for the California Register of Historical Resources (CRHP). When the number of cultural resources listed in the NRHP are tabulated, that number will not correspond to the number of resources that are also considered eligible for inclusion in the NRHP, but not actually listed. For some counties in California, the number of eligible and listed sites are considerably different because the NRHP nomination forms are not yet completed, although the California State Historic Preservation Officer has concurred with a determination that a resource is eligible.

### Indian Trust Assets

Indian Trust Assets are legal interests in assets held in trust by the Federal government for Indian tribes or Indian individuals. Assets can be real property, physical assets, or intangible property rights. Indian Trust Assets cannot be sold, leased, or otherwise encumbered without approval of the United States Government. A trust relationship is established through a Congressional Act or Executive Order as well as provisions identified in historic treaties.

An example of an Indian Trust Asset is land associated with a reservation, rancheria, or public domain allotment. The Sacramento River basin includes approximately 25 reservations and rancherias and an unknown number of public domain allotments. Eleven reservations or rancherias are located in the counties that make up the San Joaquin River basin. The resources located within reservations include trees, minerals, oil and gas, and other resources. Water rights as well as hunting and fishing rights may be Indian Trust Assets, although under P.L. 280, fishing and hunting are regulated under State law by the DFG, both on and off reservation.

## WATER RESOURCES DEVELOPMENT

Chapter 3 of the Post Flood Assessment (March 1999), which was prepared as part of the Comprehensive Study, provides a detailed description of the physical features and operations of the flood management and water supply systems in the Sacramento and San Joaquin River basins. The following sections summarize this information about these systems.

## SACRAMENTO RIVER BASIN

## FISH AND AQUATIC ECOSYSTEMS

The Sacramento River and its tributaries provide important spawning and rearing habitat for both anadromous and resident fish. Anadromous species in the Sacramento River basin include chinook salmon, steelhead, green and white sturgeon, striped bass, American shad, and Pacific lamprey. Resident species include white and channel catfish, crappie, carp, blue gill, tule perch, largemouth black bass, Sacramento squawfish, and Sacramento sucker. Several of these species have been introduced to the system. These include striped bass, American shad, white and channel catfish, crappie, carp, blue gill, and largemouth bass. The following species of concern inhabit the Sacramento River: chinook salmon, steelhead, green and white sturgeon, Sacramento splittail, and Delta smelt.

The Sacramento River supports four different races of chinook salmon: fall-, late fall-, winter- and spring-run. Fall-run chinook salmon is presently the predominant run in the Sacramento River. About 90 percent of the salmon spawning in the Central Valley spawn in the Sacranto River system ( CVPIA 1997). The Feather and American River basins are major tributaries that support chinook salmon, steelhead trout, striped bass, and American shad populations. Several east side tributaries, including Battle, Deer, Mill, Butte, and Big Chico creeks, maintain small, but significant, runs of spring-run chinook salmon. Four hatcheries produce chinook salmon in the Sacramento River basin: Coleman National Fish Hatchery, Sacramento Rearing Facility, Feather River Fish Hatchery, and the Nimbus Fish Hatchery. Steelhead populations are also supplemented by hatcheries in the Sacramento River basin.

Water and land development in the Sacramento River basin has led to a 95 percent reduction of historical salmonid spawning and rearing habitat (California Rivers 1993). The ability for salmonids to spawn naturally in the Sacramento River basin has been limited by the construction of numerous barriers to migration, such as Shasta and Keswick Dams on the Sacramento River. Dams and water diversions have blocked migrating steelhead on the major tributaries of the Sacramento River. These include Oroville Dam on the Feather River, Englebright Dam on the Yuba River, and Nimbus Dam on the American River.

Delta smelt are listed as a threatened species by the State and Federal governments. Historically, Delta smelt were sited as far upstream on the Sacramento River as the city of Sacramento. Declines in the Delta smelt population have coincided with changes in Delta hydrology, freshwater exports, and the accompanying changes in the temporal, spatial, and relative ratios of water diversions (USFWS 1996).

The Sacramento splittail is listed as threatened under the ESA; the State has not proposed or listed this species. Splittail historically have been found in the Sacramento River as far north as Redding and were formerly a commercially harvested species. Habitat loss and modification, annual flow variation, and entrainment into water diversions from the Delta are factors that likely affect the abundance of Sacramento splittail (USFWS 1996).

Distribution and abundance of fish species in the Sacramento River system are influenced by habitat characteristics (e.g., pools, riffles, runs, and shaded riverine aquatic habitat), migration patterns, predation, barriers to migration, water temperature, fishing, and nutrient abundance. To better understand the relationships between river and floodplain, DWR and CALFED are studying the relationships between the Yolo Bypass and the estuary. Initial fish sampling was conducted in the Yolo Bypass during 1997. Preliminary results reveal that the bypass supports a higher species diversity than does the Sacramento River; native species were more common in the river (Sumner et. al, 1998).

Levees construction and channel straightening have greatly reduced the occurrence of sloughs, side channels, organic materials, and invertebrate and fish habitat quality. For example, an estimated 95 percent of the riparian forest along the mainstem of the Sacramento River has been lost since the early 1800's (CALFED 1998). With the decline of the riparian forest, the system has experienced a loss of riparian inputs to the aquatic system. This, in addition to the removal of woody debris to increase flood conveyance, has altered important structural elements that provide and shape complex physical and biological habitats along the Sacramento River mainstem (National Research Council 1996).

The Sacramento Valley historically contained an estimated 1,400,000 acres of wetlands; approximately 170,000 acres remain (CALFED 1998). Riparian and wetland habitats provide food and shelter to aquatic fauna, as well as attenuate high flows. Nutrients entering the river from terrestrial sources form the base of the food web in the Sacramento River. Confining the river between narrowly-spaced levees has decreased or eliminated the connection of the river to its floodplain. This, in turn, has reduced nutrient inputs and habitat complexity over historic conditions.

## PLANT COMMUNITIES, WILDLIFE AND TERRESTRIAL ECOSYSTEMS

The Sacramento River basin supports a large diversity of species and a wide variety of lowland and upland habitats. Remnants of riparian communities along the Sacramento River and tributaries are all that remain of once productive and extensive riparian areas. Wetlands occupy some areas along Sacramento River basin waterways. Grasslands and wooded upland communities are abundant in the higher elevations within this basin. Agricultural lands occupy the major portion of the Sacramento Valley. Open-water areas are primarily the larger waterways and areas where waterways converge.

### Historical Perspective

Perhaps the most drastic difference between the historic Sacramento River basin and the present one is the current lack of lush, unbroken riparian forest. Most riparian forests were destroyed and fragmented by development, agriculture, and harvesting for firewood and construction. The native perennial grasslands that once covered vast areas of the basin have been converted to agricultural crops or significantly altered by invasive non-native annuals.

Low-lying floodplains in the basin were periodically, naturally inundated, replenishing nutrients and providing water to portions of the basin not situated along waterways. Construction of levees to protect agricultural lands resulted in the loss of those ecosystems which depended upon periodic flooding. Vernal pools were important wetland resources that were once abundant. They have decreased dramatically with the agriculture and development since the mid-1800's.

***Natural and Agricultural Communities.*** Changes in the natural landscape of the Sacramento River basin began soon after the Spaniards first settled in California during the 1770's. Spanish settlers introduced a wide variety of annual grasses and forbs from the Mediterranean region. During the 1800's, hundreds of additional non-native plants arrived from around the world during the 1800's. Many of these introduced species were aggressive and successfully out-competed native species and became naturalized. Grasslands were severely altered by the introduction of non-natives. By 1945, most of the basin's grasslands were no longer dominated by native plants. The conversion of many grasslands to irrigated croplands and urban areas also contributed to the decline in the extent of native grasslands.

The Sacramento River basin floodplains once supported vast riparian woodlands along the major rivers. Historical maps and accounts indicate the existence of continuous forests up to 5 miles wide along the Sacramento River, plus extensive forests on high terraces even farther from the river. Pre-settlement estimates of riparian vegetation along the Sacramento River range from 800,000 to 1,000,000 acres.

Within a few decades of the discovery of gold, riparian forests in the Sacramento River basin were removed to fuel boats, to build and heat towns, and to prepare land for levees, farms, and harbors. By 1939, nearly 90 percent of the historic riparian zone was eliminated. In the mid-1980's, the area of mature riparian forest along the Sacramento River was estimated to be 2 percent of the historical riparian forest.

The higher elevations within the Sacramento River basin are dominated by conifers and hardwoods. These forests have experienced some development and logging, but the percentage of habitat loss is less than in other parts of the region.

***Waterfowl and Shorebirds***. Waterfowl in the Sacramento River basin outnumber shorebirds. Since the late 1800's, both groups have experienced population fluctuations. Until the 1920's, market hunting until the 1920's affected many waterfowl populations in the basin. Conversion of natural habitats to agricultural and urban uses, and drought contributed to declines in numbers of waterfowl and shorebirds using the basin. After the mid-1930s, waterfowl populations in the basin increased. Favorable weather patterns on the Canadian breeding grounds, and a reduction in hunting as men entered the military during World War II may have contributed to these increases. Labor shortages during this period may have extended the time required for harvesting rice and other grains, thereby providing additional forage for waterfowl. During the late 1950's and mid-1980's, bird populations declined due to unfavorable conditions in their breeding grounds. Populations recovered, however, after these periods of decline.

## Existing Conditions

The Sacramento River basin contains numerous habitat types. These habitats are discussed in the following sections.

***Natural and Agricultural Communities.*** Mixed coniferous forest is the most abundant natural community in the Sacramento River basin (3,690,000 acres). The lowland areas of the basin are dominated by agricultural land, occupying approximately 1,984,000 acres. Agricultural crops in the basin include grains, pasture, rice, orchards and vineyards, and vegetables. Grains and pasture are the most abundant crops in the region at 601,000 and 442,000 acres, respectively. Approximately 242,000 acres are naturally unvegetated (barren) land in the northeast portion of Shasta County that consists of lava beds and similar substrates unsuitable for vegetation.

Estimates of riparian vegetation acreage in the basin vary widely. There are 13,107 acres of young trees, sub-climax, and climax native vegetation on high and low terraces along the Sacramento River from Colusa to Keswick Dam (excluding vegetation along tributary rivers and streams). The lower 60 miles of the Sacramento River are leveed and support relatively little riparian vegetation. Approximately 157,000 acres of wetlands occur in the Sacramento River basin, comprising 1.3 percent of the region. Open water accounts for 122,000 acres, or 1 percent of the region.

***Special-Status Species.*** Sacramento River basin is home to 65 special-status plant species and 39 special-status wildlife species. Most of the plant species live in grasslands, including vernal pools. The next-greatest number of special-status species inhabits in chaparral and montane hardwood. Most of the special-status wildlife species inhabit grasslands, freshwater emergent wetlands, lakes, and rivers on the valley floor. Many species have been listed by Federal and State wildlife agencies.

***Waterfowl and Shorebirds.*** Approximately 60 percent of the Pacific Flyway waterfowl population winters in the Sacramento Valley. In 1991, midwinter waterfowl surveys estimated 2,127,800 waterfowl in the Valley, including approximately 1,432,000 ducks and 572,800 geese.

Valley wetlands also provide important habitat for shorebirds. During winter 1992-1993, biologists counted more than 140,000 shorebirds in the Valley. The Sacramento Valley is particularly important in the spring, when 30,000 to 300,000 shorebirds use its wetlands as staging areas during migration to northern breeding grounds.

## SOCIOECONOMICS

### Demographics

Between 1920 and 1950, the population of the Sacramento River basin more than doubled. Population growth was relatively constant between 1920 and 1940; however, it increased dramatically between 1940 and 1950. During this decade, the basin experienced its greatest growth in population, increasing from approximately 488,000 to 754,000. This increase coincided with the movement of military personnel to the State during World War II, and the post-war era. Activity at Mather, McClellan, and Beale Air Force Bases near Sacramento influenced regional growth. Between 1950 and 1990, the population of the basin increased from approximately 754,000 to 2.2 million.

### Agricultural Economics

Patterns of employment growth in the Sacramento River basin reflect the changing rural and urban complexion of the region. While production agriculture provides less than 4 percent of wage and salary employment, the percentage varies widely among the counties. In 1992, production agriculture accounted for 33 percent of employment in Colusa County, 19 percent in Glenn County, and 16 percent in Yuba County. However, it accounted for less than 1 percent in Sacramento, Placer, and Nevada counties.

The market value of crops in the basin reached $1.7 billion in 1993. Rice, tomatoes, almonds, and walnuts were the most valuable crops.

## LAND USE

### Urban Lands

Urban land use data for the Sacramento River basin were not collected for the period prior to 1922. Therefore, the data on urban land use are presented beginning in 1930. Between 1930 and 1950, urban land use in the Sacramento River basin increased from approximately

58,000 acres to 104,000 acres. Much of the urban land use increases were associated with the growth of the city of Sacramento. Developed land within the remainder of the region was used primarily for agriculture and associated activities.

Urban land use, which includes M&I use, in the Sacramento River basin increased after 1950, in part as a result of the post-World War II expansion and favorable economic conditions. Between 1950 and 1980, urban corridors developed along Interstate 80 from Fairfield to Auburn and along Highway 50. During this time, development included growth in Sacramento, which transformed the area from being the State capital and a regional transportation center for agriculture, to an area that supported aerospace, electronics, and computer industries.

Between 1980 and 1990, urban land acreage within the basin increased from approximately 316,000 acres to 444,000 acres. Urban land use within the basin is concentrated in and around the city of Sacramento and along the major highway corridors leading out of the city and into the Solano County area. As the State capital, Sacramento is the site of many State and Federal government offices. Its location in proximity to major transportation corridors, combined with its central location within the State, has made the city the largest urban land use area within the Central Valley.

Rapid growth in single and multi-family housing has had a major impact on the Sacramento county area, as well as on the surrounding areas of Placer, El Dorado, Butte, Yolo, Solano, and Sutter counties. Suburban houses often surround urban areas in this region. During the 1980's, western Placer County and the Sacramento area were among the fastest growing areas in California. Irrigated agricultural acreage in the region peaked during the 1980's, but has since declined due to the conversion of these lands to urban land uses.

### Agricultural Land Use

Conditions in the basin cause a wide variation in crop mix. The uplands are suitable for a variety of crops, but the fine-textured soils adjacent to the Sacramento River are most suited to rice production.

In 1992, there were approximately 12,500 farms in the basin. Average farm size was approximately 375 acres. The average farm had 168 acres of cropland, of which 116 acres were irrigated and 122 acres were harvested. Pasture accounts for much of the difference between cropland and harvested cropland. Over the 5-year period from 1987 to 1992, the number of farms declined from 13,100 to 12,600, and total cropland fell from 2.2 to 2.1 million acres. The amount of irrigated cropland rose from 66 to 69 percent.

Approximately 88 percent of the valley floor is in farms and ranches. Combined with the San Joaquin Valley, the Sacramento Valley produces 250 different commodities valued at more than $13 billion annually (American Farmland Trust, 1997). Principal crops grown include cotton, fruits, nuts, grapes, hay, grain, rice, alfalfa, citrus, and tomatoes. This area accounts for 15 percent of the nation's vegetable production, 38 percent of the fruit production, and 9 percent of the dairy production.

Development pressures in the Sacramento Valley have grown rapidly due to the proximity of the valley to both the Bay area and the Interstate 80 transportation corridor between Sacramento and San Francisco. Between 1981 and 1992, urban development more than tripled. Population growth in Sacramento County between 1980 and 1992 was thirteenth highest in the nation (American Farmland Trust). The population of the Central Valley is projected to triple between now and the year 2040.

### Wildlands and Conservation Lands

In the Sacramento River basin, close to 50,000 acres are managed by the State and Federal governments. Federal lands include the Sacramento, Delvan, Colusa, and Sutter National Wildlife Refuges. State lands include Gray Lodge, Upper Butte, and Oroville Wildlife Management Areas. These refuges are discussed in detail in Appendix J. Together with private duck clubs, these State and Federal lands provide essential habitat for wintering waterfowl and shorebirds. Approximately 55 percent of the waterfowl that winter in the Central Valley depend on wetlands in the Sacramento Valley (CVHJV, 1990).

## WATER SUPPLY

Urban water use in the Sacramento River basin is concentrated within the City of Sacramento metropolitan area and near the City of Redding. Sacramento is the largest urban area in the Central Valley. Other areas of rapid urban growth in the region are located within Placer, El Dorado, Yolo, and Sutter counties. The City of Redding in Shasta County, with a 1990 population of 64,600, has also grown rapidly in recent years. Redding is an agricultural, transportation, and services center for the north Sacramento Valley. See the discussion of water supply under System-Wide Context and Conditions at the front of this chapter for a more detailed discussion of water supply facilities in this basin.

## CULTURAL RESOURCES

There are at least 294 sites within the Sacramento River basin that have been listed on the NRHP as individual properties or as districts. In addition, 224 sites in the region have ben listed as California Historical Landmarks, and 196 sites are listed as California Points of Historical Interest.

### Prehistoric Resources

The primary Native American groups known to have occupied the Sacramento River basin include the Achumawi, Atsugewi, Konkow, Maidu, Nisenan, Nomlaki, Yana, and Wintu. Some of the natural or geologic features of the region are traditionally considered sensitive or sacred. As examples of the sacred natural landscape, the Konkow and the Maidu considered Sutter Buttes as the location from which spirits of the dead left for the afterworld. Butte Mountain is the site of the first Hesi ceremony performed by ancestors of the Nisenan. The Nomlaki considered Lassen Butte to be the home of a spiritual figure. Sutter Buttes and Mount Shasta are places of cultural importance to the Patwin and Wintu.

Many prehistoric site types that have been recorded in the basin and include village sites, temporary campsites, milling sites, petroglyphs, lithic scatters, quarry sites, and burial sites. Acorn processing sites are commonly found in the oak woodland. Habitation sites and bedrock mortar or other milling sites are the most common types found in these areas. Many burial or cremation sites also exist within the Sacramento River basin. Because the area was intensively occupied in prehistoric times, prehistoric resources are common throughout the region; however, many of these sites have been disturbed or destroyed primarily due to agricultural development.

### Historic Resources

Historic resources are likely to occur throughout the region. The majority of historic site recorded in the basin and listed on the NRHP consist of local structures, such as houses, schools, libraries, churches, post offices, hotels, railroad stations or related features, mine sites and bridges. Additional historic sites that have been recorded and that may likely occur within the upper watersheds include mining-related structures or features, railroad grades and associated features, dams and culverts, and refuse deposits. Mining in the Sierra Nevada was widespread in the second half of the $19^{th}$ century, and numerous railroads were established throughout the region. In addition, attempts to irrigate the valley and bring potable water to San Francisco created many irrigation features.

## WATER RESOURCES DEVELOPMENT

Table 3-1 of the Post Flood Assessment contains the project name, authorization, date completed, location, total capacity, flood management reservation, and physical characteristics for each major flood storage project in the Sacramento basin. Following is a summary of the major elements of the Sacramento River flood management system, which incorporates features of various flood damage reduction and water supply projects. Chapter 3 of the Post Flood Assessment provides more detailed descriptions of the structural features of the flood management system, and of their operations.

### Sacramento River Flood Control Project and Seasonal Flood Detention Storage in Separately-authorized Multipurpose Reservoirs

The basic feature of the Sacramento River flood management system is the Sacramento River Flood Control Project. This project, as originally authorized and supplemented by subsequent projects, includes the following major features:

- approximately 1,300 miles of levees along the Sacramento River extending from River Mile (RM) 0 at Collinsville to Chico Landing, RM 194, distributary sloughs, the lower reaches of the major tributaries (American, Feather, Yuba and Bear Rivers) and additional minor tributaries;

- the Moulton, Colusa, Tisdale, Fremont, and Sacramento Flood Overflow Weirs; and

- The Butte Basin and Sutter and Yolo Bypasses and Sloughs.

The Sacramento River Flood Control Project basically mimics the natural historic flooding patterns. The project levees begin on the right (west) bank just downstream of Chico Landing. Upstream of the levees, high flows on the river flow into the Butte Basin, a trough created by subsidence, to the east. The Colusa Basin Drain, a similar trough located to the west of the river, intercepts runoff from west side tributaries.

The Tisdale Weir is usually the first flood overflow structure to spill. When the Sacramento River reaches 23,000 cubic-feet per second (cfs), flows spill over the Tisdale Weir, through the Tisdale Bypass and into the Sutter Bypass. The Colusa Weir is the next structure to spill; when the river reaches 30,000 cfs, flows spill into the lower Butte Basin via the Colusa Bypass. Flows spill over the Moulton Weir into the Butte Basin at 60,000 cfs. In comparison, at 90,000 cfs upstream of the levees, overflows start into the Butte Basin, and if flood flows exceed 300,000 cfs upstream of the levees , the Sacramento River could be expected to spill into the Colusa Basin.

During major flood events, the three major upstream reservoirs-Shasta on the Sacramento River, Folsom on the American River, and Oroville on the Feather River, and the Butte Basin intercept and store initial surges of runoff and provide a means of regulating floodflow releases to downstream leveed streams, channels, and bypass floodways. To achieve the full benefits of the reservoirs, specific downstream channel capacities must be maintained. Reservoir operation is coordinated not only among various storage projects but also with downstream channel and floodway carrying capacities.

Shasta is a multipurpose dam that controls runoff 6,420 square miles excluding Goose Lake. The project serves agricultural, municipal, and industrial demands through provision of 4.5 million acre-feet of total storage, 1.3 million acre-feet of which is allocated to flood control.

Electric power generation is an integral component of system operation. At Colusa, the local drainage area of the Sacramento River, between Shasta Dam and Colusa, is 6,180 square miles. The only flow control in the reach is Black Butte Dam on Stony Creek. This dam creates a 144,000 acre-foot multipurpose reservoir. Oroville Dam provides 3.5 million acre-feet of storage on the Feather River for several purposes; 750,000 acre-feet of storage is allocated to flood control. The north fork of the Yuba River is uncontrolled except for New Bullards Bar Dam, which provides 960,000 acre-feet of storage (170,000 acre-feet is for flood control).

The Sacramento River Flood Control System (reservoirs, original levees, and bypasses) provides protection to about 2.1 million acres of highly productive agricultural land, as well as to the cities of Sacramento, West Sacramento, Yuba City, Marysville, Colusa, Gridley, Live Oak, Courtland, Isleton, Rio Vista and numerous smaller communities. The Valley is laced with agriculture and related infrastructure, including irrigation works (diversions, pumping plants, canals and drains), roads and bridges. Major transportation routes are Interstate Highways 5 and 80, and State Highways 50, 99, 45, 20, and 160.

The flood management system responsible for protecting these resources in the Sacramento Valley has expanded with the addition of projects, such as the Sacramento River and Major and Minor Tributaries Flood Control Project, the Chico Landing to Red Bluff Project, and the Sacramento River Bank Protection Project. These projects are described in the next sections.

### Butte Basin Overflow Area

Upstream of Ord Ferry, floodwaters in the Sacramento River overflow the east bank of the river into the Butte Basin at three sites in a reach referred to by the State as the Butte Basin Overflow Area. This area extends roughly from RM 176 to RM 194. The purpose of the Butte Basin Overflow Area is to ensure and maintain a split of floodflows between the Sacramento River and the Butte Basin in order that flows in the river do not exceed the channel capacity downstream. The flood control project features in this reach consist of three designated overflow locations: the M&T flood relief structures (FRS's); the 3B's natural overflow site; and the Goose Lake FRS. Within the Butte Basin, the State regulates land use through a permitting authority.

The Butte Basin Plan of Flood Control project was designed by the State so that flow in the Sacramento River at RM 176 would not exceed 150,000 cubic feet per second (cfs). The capacity of the next downstream leveed channel reach is 160,000 cfs. Because the design flow at the upstream end of the Butte Basin Overflow Area is 300,000 cfs, the three designed overflow sites must collectively split 150,000 cfs into Butte Basin. The Butte Basin acts as a detention reservoir, discharging flows into Sutter Bypass.

### Sacramento River and Major and Minor Tributaries Flood Control Project

The Sacramento River and Major and Minor Tributaries Flood Control Project, authorized in 1944, includes the following major features:

- Levee construction and channel improvement on the Sacramento River from Colusa to Chico Landing and on lower reaches of its tributaries from the mouth of Butte Creek to Red Bluff.

- Revetment and levees in the Sutter, Tisdale, Sacramento, and Yolo Bypasses.

Authorized improvements on Butte Creek, Chico Creek, Mud Creek, and Sandy Gulch, Elder Creek, Deer Creek, and Cherokee Canal have been completed, and some bypass levee revetment work has been done. Construction of about 72 miles of channel work and 197 miles of levee have been completed.

### Sacramento River, Chico Landing to Red Bluff Bank Protection Project.

The flood control project was extended upstream to Red Bluff via the Sacramento River, Chico Landing to Red Bluff Bank Protection Project. Approximately 18 miles of bank protection at 36 sites have been completed; about 15 miles of bank stabilization remain to finish this project. The project is inactive due to a Jeopardy Opinion by the FWS in 1985 regarding the valley elderberry longhorn beetle.

### Sacramento River Bank Protection Project

The bank protection project provides a long-range program to protect the flood control system from erosion. The project includes a total of 835,000 lineal feet of bank protection in two phases: 430,000 lineal feet in the first phase, and 405,000 lineal feet in the second.

This project was authorized in 1960 and the first phase of construction was completed between 1963 and 1974, and work began in 1974 under the second phase authorization. A total of approximately 86,000 feet of the second phase has not yet been completed. Of this amount, between 16,000 and 31,000 lineal feet (best current estimate of about 26,000 lineal feet) are currently being defined in Design Memorandum Supplements 7 and 8 for sites on the Sacramento and American Rivers. Implementation of the project has slowed dramatically due to environmental concerns.

Historically, most of the bank protection work entailed placing rock riprap on the river banks, levees and berms. Other types of protection include palisades, setback levees, wind-rowed rock, trenched revetment, and gabions. Currently, bank protection plans are being formulated that include re-constructed natural features such as hard points and embayments, synthetic fabric-encapsulated soil, and woody instream cover structures.

# SAN JOAQUIN RIVER BASIN

## FISH AND AQUATIC ECOSYSTEMS

The San Joaquin River above the confluence of Merced River has no remaining significant native fishery. Below Merced River, the San Joaquin River is dominated by introduced warmwater fish species. Common species include: green sunfish, bluegill, redear sunfish, largemouth bass, black crappie, threadfin shad, common carp, Sacramento blackfish, white catfish, black bullhead, brown bullhead, and mosquito fish. Remnant populations of native fish species are also present, including some anadromous species in the tributaries.

Historically, the upper San Joaquin River provided habitat for the southern-most stocks of spring-run and fall-run chinook salmon, and most likely steelhead. It is estimated that the basin once supported 100,000 to 300,000 chinook salmon, most of which were spring-run. Dam construction in the early and mid-1900's has eliminated Spring-run chinook salmon from the mainstem and tributaries to the San Joaquin River. Consequently, chinook salmon production in the basin has declined by over 85 percent since the 1940's (USACE 1993).

The basin now supports only fall-run chinook salmon, on the Merced, Tuolumne, and Stanislaus Rivers. However, fall-run escapements have been extremely low in recent years with only about 600 spawning fish in 1991 (California Rivers 1993). Other anadromous species rarely migrate up the San Joaquin River, although many species enter the lower San Joaquin River near the Delta. Chinook salmon populations are augmented with fish reared in two hatcheries: Merced River Fish Hatchery and Mokelumne Fish Hatchery. Fisheries biologists have expressed concern that hatchery fish may alter gene pools and adversely affect genetic fitness of wild populations by interbreeding with wild stocks.

Flow releases from Friant Dam are maintained year round, but the required 5 cfs measured at Gravelly Ford rapidly infiltrates into the gravel substrate near Gravelly Ford. The net result is no flow from Gravelly Ford to Mendota Pool, except during very high runoff events. The river channel often does not have water again until agricultural return flows begin to make up the majority of flow around Madera Pool. As a result, the river contributes a higher amount of nutrients and salts to the Delta than does the Sacramento River. Nutrients transported by the San Joaquin River can benefit the Delta ecosystem. However, in areas that are poorly flushed, large concentrations can also cause oxygen depletion and nutrient loading, which may be detrimental to fish.

## PLANT COMMUNITIES, WILDLIFE, AND TERRESTRIAL ECOSYSTEMS

The San Joaquin River basin is similar to the Sacramento River basin in terms of terrain, climate, habitats, and species. However, historic and present differences between the two regions do exist. For example, riparian areas in the San Joaquin River basin are not, and have not been, as extensive as those found in the Sacramento River basin. The San Joaquin River basin has more land devoted to agriculture. Many riparian communities within the San Joaquin River basin declined or vanished when historic waterways ran dry as water was diverted for agriculture use.

### Historical Perspective

The San Joaquin River basin has lost most of its historic riparian areas. This loss is largely the result of agricultural activities which developed early and expanded rapidly. Agriculture has remained the dominant land use in the basin. Historically, the lowlands of the San Joaquin River supported vast expanses of permanent and seasonal marshes, lakes, and riparian areas. Almost 70 percent of the lowlands has been converted to irrigated agriculture. Wetland acreage has been reduced to 120,300 acres, or about 10 percent of historic wetland area in the San Joaquin Valley and about 4 percent in the Tulare Basin.

Upland shrubs and oak woodlands that surround the San Joaquin Valley to the east, west, and south are less intact than they were prior to the twentieth century. Development and water diversions adversely affected some of these areas. Wetland areas were once very common in the northern, southern, and parts of the western reaches of the Valley, but since the mid-nineteenth century they have been reduced to a fraction of their historic acreage.

***Natural and Agricultural Communities.*** Significant changes to the natural landscape in the San Joaquin River basin began during the late nineteenth century. Agriculture developed quickly, and numerous waterways were altered and channels constructed in order to irrigate these agricultural lands. Many plant communities and wetland areas were lost due to a reduction in available water. As the use of pesticides increased in the twentieth century, many wetlands were contaminated by the runoff from the agricultural fields. By the mid-twentieth century high salinity became apparent. Repetitive irrigation and high evaporation in the low-lying areas of the San Joaquin Valley left many minerals and salts behind. Some areas became unusable for agriculture, and nearby wetlands were adversely affected by the saline runoff from these lands.

Historically, wetlands were abundant in the San Joaquin River basin’s northern and southern reaches. Wetlands most affected by the minerals, salts, and pesticides were those in the south-central and southern portions of the region where many waterways terminated. Losses of other wetlands in the region resulted from water diversions.

Riparian areas along the wetlands and waterways of the San Joaquin River basin were historically not as abundant as those of the Sacramento River basin, but many dense, continuous stands were present into the mid-nineteenth century. Eventually, most were cut down for firewood and construction, or were cleared to make way for agriculture. By 1939, nearly 90 percent of the region's historic riparian zones was eliminated. Currently, riparian communities cover about 4 percent of their historic area. An example of remnant riparian habitat is Caswell State Park. Non-native trees such as eucalyptus were introduced into the region to serve as wind breaks adjacent to many agricultural areas.

Plant communities in upland areas of the San Joaquin River basin include a large number of introduced species. Grasslands are primarily composed introduced grasses and forbs.

The higher elevations within the San Joaquin River basin are dominated by conifers and hardwoods. These areas have experienced some development and have been logged, but the percentage loss of habitat is less than other habitat types.

***Waterfowl and Shorebirds.*** Waterfowl and shorebird numbers in the San Joaquin River basin were historically greater than those in the Sacramento River basin. In addition to the factors that reduced waterfowl and shorebird populations in the Sacramento River basin, the accumulation of minerals and pesticides further reduced wetlands extent and quality in the San Joaquin Valley. This, in turn, may have contributed to the decline in waterfowl and shorebird populations. Initially, waterfowl and shorebird recovery in the San Joaquin River basin was not as successful as in the Sacramento River basin. Recent efforts to restore damaged wetlands, prevent harmful runoff from entering the wetlands, and manage agricultural lands to favor waterfowl and shorebirds during the winter months have aided recovery of these species.

### Existing Conditions

The region's lowlands are similar to those in the Sacramento River basin, but tend to be more arid in places. Natural communities in the basin include native and non-native grasslands, wetlands, sparse riparian zones, chaparral, mixed coniferous woodlands, and foothill hardwood woodlands.

***Natural and Agricultural Communities***. The natural terrestrial community types in the San Joaquin River basin occupy approximately 4.6 million acres out of a total land area of 8.3 million acres. Grassland, dominated by non-natives, is the most abundant natural community in this region. There are about 1.1 million acres of grasslands, mostly on the edges of the valley floor. Valley foothill woodland is the next-most-common natural community, occupying 1.4 million acres of the foothill areas of the region. The lowland areas of the San Joaquin River basin are dominated by approximately 3.1 million acres of agricultural land. Crops include pastures, orchards and vineyards, vegetables, cotton, grains, and rice. Pastures, orchards, and vineyards are the most abundant croplands in the region. An estimated 30,800 acres of riparian vegetation existed in the San Joaquin River basin in 1977.

Approximately 138,000 acres of freshwater emergent wetlands occur in the San Joaquin River basin, mostly in western Merced County. Upland chaparral and woodland communities are drier than those in the Sacramento River basin, and remained relatively intact compared to their historic extent except for some clearing for logging and grazing.

***Special-Status Species.*** Currently, 69 special-status plant species and 45 special-status wildlife species are found in the San Joaquin River basin. The largest number of special-status plant species (18) grow in grasslands. The second-largest number (16) occurs in valley foothill woodland. Most special-status wildlife species are associated with grasslands, freshwater emergent wetlands, lakes, and rivers that occur on the valley floor. Many of these species have been listed by Federal and State wildlife agencies.

***Waterfowl and Shorebirds.*** The San Joaquin River basin supports approximately 25 percent of the Central Valley waterfowl and shorebird populations and up to 30 percent of the wintering duck population. In 1992 to 1993, winter shorebird numbers were estimated at 66,700 birds. Between 1988 and 1992, biologists estimated that 100,000 to 1 million shorebirds were present in the valley during annual spring staging.

## SOCIOECONOMICS

### Demographics

The population of the San Joaquin River basin more than doubled between 1920 and 1950. The majority of this change occurred from 1940 to 1950, as the population increased from approximately 483,000 to approximately 739,000. Between 1950 and 1990, the population of the region increased from approximately 739,000 to 1.9 million. For the entire period between 1920 and 1990, the population of the San Joaquin River basin increased by approximately 1.6 million people. The total population increase during this time was accompanied by changes in composition of the population. Changes occurred in the age distribution, ethnicity, and education levels of the population.

Major urban centers in the San Joaquin River basin include Fresno, Stockton, Modesto and Merced (1990 population 55,700). These cities are regional hubs for food transportation and processing. Growth in Tracy (1990 population 32,400) and Stockton has recently been fed by San Francisco Bay area growth trends. The City of Fresno is the largest urban center in the San Joaquin Valley. The City of Bakersfield is the main urban center within the Tulare Lake basin. Other municipal areas in the Tulare Lake basin include Tulare, Hanford, and Visalia.

### Agricultural Economics

In the San Joaquin River Region, fruits and nuts accounted for approximately half of the total value of crop production ($4.7 billion) in 1993. Vegetables and cotton accounted for approximately 20 and 10 percent of the San Joaquin River Region's value of crop production, respectively.

## LAND USE

### Urban Land Use

Municipal and industrial land use data for the San Joaquin River Valley are not available for the period between 1920 and 1930. Therefore, the data on urban land use are presented beginning in 1930. Between 1930 and 1950, urban lands within the region were located primarily in valley towns such as Stockton, Madera, and Modesto. During this time, urban acreage within this region doubled, increasing from approximately 16,000 acres in 1930 to 32,000 acres in 1950.

Between 1950 and 1990, urban acreage throughout California increased in response to the rapid population growth. Increases in urban are in the San Joaquin Valley occurred primarily in Fresno, Merced, Stanislaus, and San Joaquin Counties. During the 1980s, towns in the Sierra Nevada foothills, including Jackson, Angels Camp, San Andreas, Sonora, and Oakhurst experienced dramatic growth rates. Between 1980 and 1990, urban land acreage within the region increased from approximately 71,000 acres to 110,000 acres.

Development pressures in the San Joaquin Valley have grown rapidly due to the proximity of the valley to both the Bay area and the Interstate 80 transportation corridor between Sacramento and San Francisco. Between 1981 and 1992, urban development more than tripled. Population growth in Fresno County between 1980 and 1992 was 25th highest in the United States (American Farmland Trust).

### Agricultural Land Use

Approximately 88 percent of the valley floor is in agricultural production. Combined with the Sacramento Valley, the San Joaquin Valley produces 250 different commodities valued at more than $13 billion annually (American Farmland Trust, 1997). Principal crops grown include cotton, fruits, nuts, grapes, hay, grain, rice, alfalfa, citrus, and tomatoes. This area accounts for 15 percent of the nation’s vegetable production, 38 percent of the fruit production, and 9 percent of the dairy production.

In 1992, there were about 20,000 farms in the San Joaquin River Region, down from more than 21,000 in 1987. Average farm size was about 250 acres. The average farm consisted of 149 acres of cropland, 125 irrigated and 123 harvested. Total cropland remained virtually unchanged (2,984,000 acres in 1987 to 2,992,000 acres in 1992) as did the amount of cropland irrigated (82 percent to 84 percent). Farms in San Joaquin and Stanislaus counties are notably smaller than those in the other counties within the San Joaquin River Region. Average farm size on the east side of the San Joaquin Valley is generally smaller than on the west side, reflecting water and soil conditions and average crop mix in the two areas.

Irrigated acreage within the river Region is very diversified. Almost half of the 1992 acreage was planted with grains, hay, and pasture. Orchards were planted on about 30 percent of the irrigated acres, and cotton and vegetables were each planted on about 10 percent. The region is the leading California area for production of grapes, almonds, walnuts, tomatoes, melons, and many other crops. Vegetables and cotton are grown on the west side, and grapes, fruits, nuts, and cotton are grown on the east side.

In 1992, agricultural production provided 8.3 percent of total wage and salary employment in the basin, or about 56,000 jobs (California Employment Development Department, 1994). From 1942 to 1992, manufacturing increased from 9.4 percent to 12.9 percent of employment, wholesale and retail trade increased from 18.3 percent to 21.8 percent, services grew from 17.5 percent to 18.6 percent, and government expanded from 3.0 percent to 18.6 percent. Currently, the largest proportions of wage and salary jobs in the region are in the services, wholesale and retail trade, and government sectors.

### Wildlands and Conservation Lands

In the San Joaquin Valley, more than 37,700 acres are managed by the State and Federal governments. These lands include Kesterson, San Luis, and Merced National Wildlife Refuges; North Grasslands, Los Banos, and Volta Wildlife Management Areas; and San Joaquin Basin Action Plan lands. Water to support wetland acreage on most San Joaquin Valley locations is provided primarily by Delta exports. The public refuges are discussed in detail in Appendix J.

## WATER SUPPLY

Water use in recent years has been affected by changes in population patterns and the recent drought (1987-1992). Between 1988 and 1990, the number of active service connections apparently decreased in Los Angeles and increased in Fresno, reflecting short-run economic conditions in these two cities. Water use per connection generally fell with the drought, especially in Santa Barbara, which was under strict mandatory conservation.

Annual use and average water bills vary greatly among providers. Summer and winter residential water use are nearly identical in the northern coastal cities, reflecting climate and landscaping practices. In the Central Valley, summer use per unit time is typically double winter use. Average annual use per residential is about 0.72 acre-foot in Sacramento. Demand during dry periods is greater than average because there is less recharge of urban landscape soil moisture (DWR 1994a).

## CULTURAL RESOURCES

There are at least 230 sites within the San Joaquin River basin that have been listed on the NRHP as individual properties or as districts. In addition, 111 sites in the region have been listed as California Historical Landmarks and 50 are listed as California Points of Historical Interest.

### Prehistoric Resources

The primary Native American groups known to have occupied the San Joaquin River basin include the Foothill Yokuts and Southern Valley Yokuts, Kawaissu, Kitanemuk, Miwok, Monache, and Tubatulabal. Table Mountain is a traditional cultural property because of its importance to the Monache who believe that mythical beings visited the mountain. The Monache have several additional places of cultural importance located within the basin.

Prehistoric sited within the basin include village sites, temporary campsites, milling sites, petroglyphs, lithic scatters, quarry sites, and burial sites. Prehistoric sites are most commonly found along the San Joaquin River and its associated sloughs. Buried sites are possible in this region due to the high rate of sedimentation. Undisturbed prehistoric sites are most likely to exist in areas not fully developed or farmed.

### Historic Resources

Historic sites recorded in the San Joaquin River basin include mining-related structures and features, railroad grades and associated features, dams and culverts, roads, refuse deposits, and architectural structures. Agricultural development of the valley has occurred since the Gold Rush era, leading to the establishment of numerous rural communities. These communities may also contain sites and structures of historical significance.

## WATER RESOURCES DEVELOPMENT

Table 3-1 of the Post Flood Assessment contains the project name, authorization, date completed, location, total capacity, flood management reservation, and physical characteristics for each major flood storage project in the San Joaquin River basin. Following is a summary of the major elements of the San Joaquin River flood management system, which incorporates features of various flood damage reduction and water supply projects. Chapter 3 of the Post Flood Assessment provides more detailed descriptions of the structural features of the flood management system, and of their operations.

A central feature of the San Joaquin River flood management system is Friant Dam, a CVP facility located on the upper San Joaquin River. Other basic features of the flood management system include levees and bypasses along the mainstem. Together with other projects, this Federal project significantly reduces the threat of flood-related damages to the primarily agricultural lands next to the river.

The original San Joaquin River and Tributaries Project consists of levees on the following rivers:

- San Joaquin River downstream of the Merced River;
- Stanislaus River;
- Old River;
- Paradise Cut; and
- French Camp Slough.

The project also includes the following dams:

- New Hogan Dam on the Calaveras River;
- New Melones Dam on the Stanislaus River;
- New Don Pedro Dam on the Tuolumne River, and
- New Exchequer Dam on the Merced River.

In addition to the approximately 100 miles of intermittent project levees along the San Joaquin River, Paradise Cut, Old River, and the lower reaches of the Stanislaus and Tuolumne Rivers, an intricate series of minor levees and channel improvements have been constructed. These are owned, operated, and maintained by local interests throughout the system.

The State's Lower San Joaquin River and Tributaries Project includes three bypasses: the Chowchilla Canal Bypass, Mariposa Bypass and the Eastside Bypass. The Chowchilla Canal Bypass, located in the upper basin, diverts flood flows from Friant Dam to reduce flood damages on downstream agricultural lands. The Eastside Bypass intercepts flows from the Chowchilla Canal Bypass, Fresno and Chowchilla Rivers, Berenda and Ash Sloughs, and Merced County Streams including Bear Creek, and carries them to the San Joaquin River.

Subsequent to the authorization of the Lower San Joaquin River and Tributaries Project the following dams were authorized and constructed:

- Buchanan and Hidden Dams on the Chowchilla and Fresno Rivers.

The Merced County Stream Group Project consists of five dry dams (Bear, Burns, Owens, Mariposa, and Castle), located in the foothills east of Merced on tributaries of the San Joaquin River, that provide flood protection to the City of Merced. The Corps owns and maintains the first four dams. Castle Dam is owned by the State and Merced County and is operated and maintained by the Merced Irrigation District. This project also includes two diversion structures (Black Rascal Creek to Bear Creek diversion and the Owens Creek to Mariposa Creek diversion).

The San Joaquin flood management system also includes the Redbank and Fancher Creeks Flood Control Project owned and operated by the Fresno Metropolitan Flood Control District. This is a single-purpose project that provides flood protection to the Fresno-Clovis Metropolitan area and nearby agricultural land. This project includes five facilities: 1) Big Dry Creek Dam and Diversion; 2) Alluvial Drain Detention Basin; 3) Fancher Creek Dam and Reservoir; 4) Pup Creek Detention Basin; and 5) Redbank Creek Detention Basin.

Los Banos Detention Dam and Camanche Dam are also part of the San Joaquin flood management system. Los Banos Detention Dam is a joint SWP-CVP dam located on Los Banos Creek, a westside tributary to the San Joaquin River. This dam provides flood protection to the San Luis and Delta-Mendota Canals, the community of Los Banos, and the agricultural lands downstream. Camanche Dam is owned, operated, and maintained by East Bay Municipal Utility District and is located on the Mokelumne River. Camanche Dam is operated in conjunction with Pardee Dam (EBMUD), and Salt Springs and Lower Bear Reservoirs (PG&E), located upstream from Camanche Dam. Required flood management reservation can be exchanged between Camanche and Pardee Reservoir.